EE 342 – Power Systems I
Assignment #4
Due date: November 14, 2005

Instructor: S.O. Faried — November 2005

1. The single-line diagram of an unloaded power system is shown in Figure 1. Reactances of the two sections of the transmission line are shown on the diagram. The generators and transformers are rated as follows:

Generator 1:	20 MVA, 13.8 kV, X''_d = 0.2 p.u.
Generator 2:	30 MVA, 18 kV, X''_d = 0.2 p.u.
Generator 3:	30 MVA, 20 kV, X''_d = 0.2 p.u.
Transformer T_1:	25 MVA, 220Y/13.8Δ kV, X = 0.1 p.u.
Transformer T_2:	single-phase units, each rated 10 MVA, 127/18 kV, X = 0.1 p.u.
Transformer T_3:	35 MVA, 220Y/22Y kV, X = 0.1 p.u.

Draw the impedance diagram with all reactances marked in per unit and with letters to indicate points corresponding to the single-line diagram. Choose a base of 50 MVA, 13.8 kV in the circuit of generator 1.

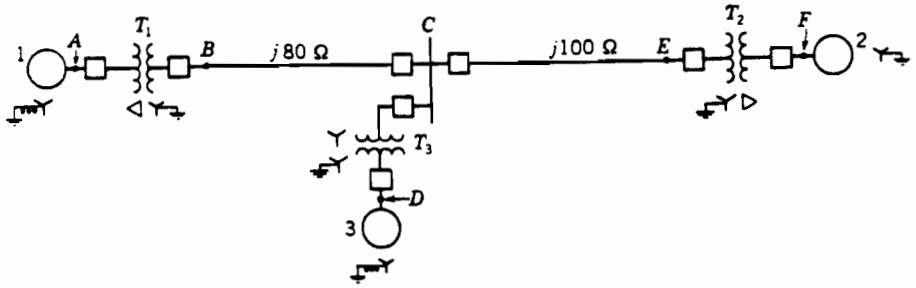
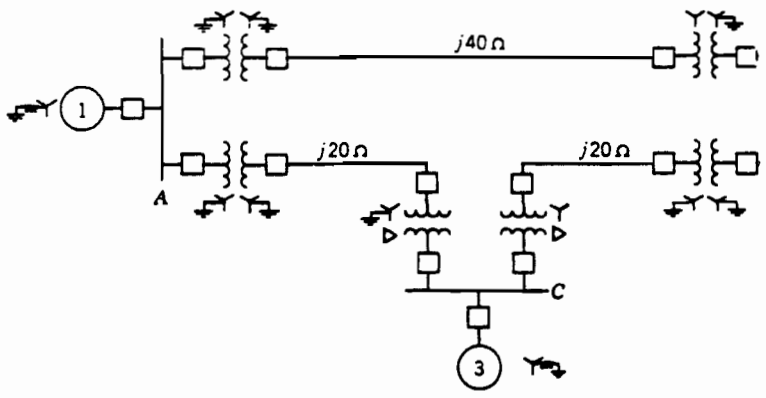


Figure 1

2. The ratings of the generators, motors, and transformers of Figure 2 are:

Generator 1:	20 MVA, 13.8 kV, X''_d = 0.2 p.u.
Generator 2:	20 MVA, 18 kV, X''_d = 0.2 p.u.
Synchronous motor 3:	30 MVA, 13.8 kV, X''_d = 0.2 p.u
Three-phase Y-Y transformers:	20 MVA, 138Y/20Y kV, X
Three-phase Y-Δ transformers:	15 MVA, 138Y/13.8Δ k

Draw the impedance diagram for the power system. Mark impedar
use a base of 50 MVA, 138 kV in the 40-Ω line.



3. Draw an impedance diagram for the electric power system shown in Figure 3 showing all impedances in per unit on a 100-MVA base. Choose 20-kV as the voltage base for generator. The three-phase power and line-line ratings are given below:

G_1:	90 MVA, 20 kV, X = 0.09 p.u.
T_1:	80 MVA, 20/200 kV, X = 0.16 p.u.
T_2:	80 MVA, 200/20 kV, X = 0.2 p.u.
G_2:	90 MVA, 18 kV, X = 0.09 p.u.
Line:	200 kV, X = 120 Ω
Load:	200 kV, S = 48 MW + *j*64 Mvar

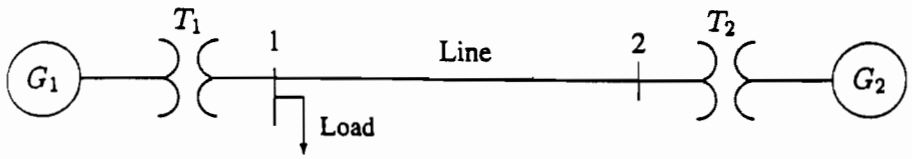


Figure 3

4. The three-phase power and line-line ratings of the electric power system shown in Figure 4 are given below:

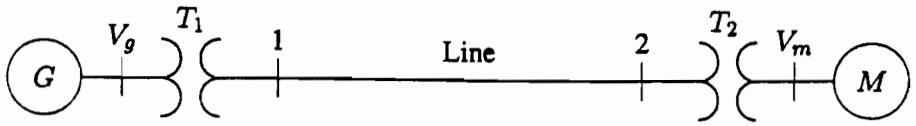


Figure 4

G_1:	60 MVA, 20 kV, X = 0.09 p.u.
T_1:	50 MVA, 20/200 kV, X = 0.1 p.u.
T_2:	50 MVA, 200/20 kV, X = 0.1 p.u.
M:	43.2 MVA, 18 kV, X = 0.08 p.u.
Line:	200 kV, Z = 120 + *j*200 Ω

(a) Draw an impedance diagram showing all impedances in per-unit on a 100-MVA base. Choose 20 kV as the voltage base for generator.

(b) The motor is drawing 45 MVA, 0.80 power factor lagging at a line-to-line terminal voltage of 18 kV. Determine the terminal voltage and the internal emf of the generator in per-unit and in kV.

(c) Repeat part (a) with 100-MVA base and 18 kV base at the generator.

(d) Repeat part (b).

5. The one-line diagram of a three-phase power system is as shown in Figure 5. The transformer reactance is 0.2 p.u. on a base of 100 MVA, 23/115 kV and the line impedance is Z = j66.125 Ω. The load at bus 2

is S_2 = 184.8 MW + j6.6 Mvar, and at bus 3 is S_3 = 0 MW + j20 Mvar. It is required to hold the voltage at bus 3 at 115 $\angle 0°$ kV. Working in per-unit, determine the voltage at buses 2 and 1.

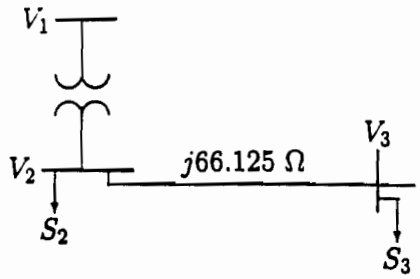


Figure 5